

## 850MHz, Low Distortion Current Feedback Operational Amplifiers

The HFA1100 is a high-speed, wideband, fast settling current feedback amplifier built with Intersil's proprietary complementary bipolar UHF-1 process. It operates with single supply voltages as low as 4.5V (see Application Information section).

The HFA1100 is a basic op amp with uncommitted pins 1, 5, and 8.

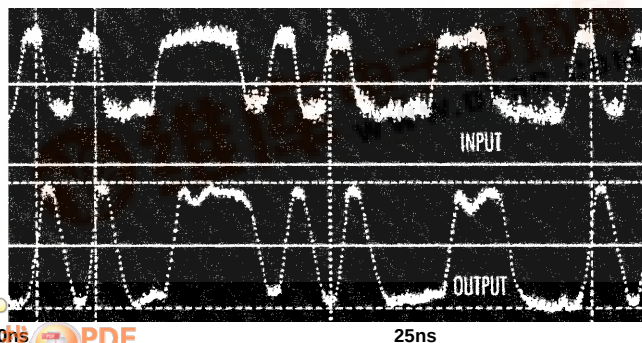
This device offers a significant performance improvement over the AD811, AD9617/18, the CLC400-409, and the EL2070, EL2073, EL2030.

### Ordering Information

| PART NUMBER<br>(BRAND)          | TEMP.<br>RANGE (°C)                         | PACKAGE                                 | PKG.<br>DWG. # |
|---------------------------------|---------------------------------------------|-----------------------------------------|----------------|
| HFA1100IP                       | -40 to 85                                   | 8 Ld PDIP                               | E8.3           |
| HFA1100IB<br>(H1100I)           | -40 to 85                                   | 8 Ld SOIC                               | M8.15          |
| HFA1100IB96<br>(H1100I)         | -40 to 85                                   | 8 Ld SOIC<br>Tape and Reel              | M8.15          |
| HFA1100IBZ (Note)<br>(H1100I)   | -40 to 85                                   | 8 Ld SOIC (Pb-free)                     | M8.15          |
| HFA1100IBZ96 (Note)<br>(H1100I) | -40 to 85                                   | 8 Ld SOIC<br>Tape and Reel<br>(Pb-free) | M8.15          |
| HFA11XXEVAL                     | DIP Evaluation Board for High-Speed Op Amps |                                         |                |

NOTE: Intersil Pb-free products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020C.

### The Op Amps with Fastest Edges



### Features

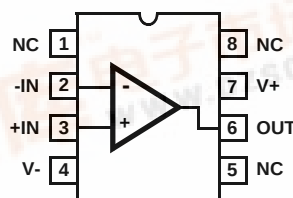
- Low Distortion (30MHz, HD2) ..... -56dBc
- -3dB Bandwidth ..... 850MHz
- Very Fast Slew Rate ..... 2300V/ $\mu$ s
- Fast Settling Time (0.1%) ..... 11ns
- Excellent Gain Flatness
  - (100MHz) .....  $\pm 0.14$ dB
  - (50MHz) .....  $\pm 0.04$ dB
- High Output Current ..... 60mA
- Overdrive Recovery ..... <10ns
- Operates with 5V Single Supply (See AN9745)
- Pb-Free Available (RoHS Compliant)

### Applications

- Video Switching and Routing
- Pulse and Video Amplifiers
- RF/IF Signal Processing
- Flash A/D Driver
- Medical Imaging Systems
- Related Literature
  - AN9420, Current Feedback Theory
  - AN9202, HFA11XX Evaluation Fixture
  - AN9745, Single 5V Supply Operation

### Pinout

HFA1100 (PDIP, SOIC)  
TOP VIEW



## HFA1100

### Absolute Maximum Ratings $T_A = 25^\circ\text{C}$

|                                       |                     |
|---------------------------------------|---------------------|
| Voltage Between V+ and V- .....       | 12V                 |
| Input Voltage .....                   | $V_{\text{SUPPLY}}$ |
| Differential Input Voltage .....      | 5V                  |
| Output Current (50% Duty Cycle) ..... | 60mA                |

### Operating Conditions

|                         |                                           |
|-------------------------|-------------------------------------------|
| Temperature Range ..... | $-40^\circ\text{C}$ to $85^\circ\text{C}$ |
|-------------------------|-------------------------------------------|

### Thermal Information

|                                                      |                                                |                                             |
|------------------------------------------------------|------------------------------------------------|---------------------------------------------|
| Thermal Resistance (Typical, Note 1)                 | $\theta_{JA}$ ( $^\circ\text{C}/\text{W}$ )    | $\theta_{JC}$ ( $^\circ\text{C}/\text{W}$ ) |
| PDIP Package .....                                   | 130                                            | N/A                                         |
| SOIC Package .....                                   | 170                                            | N/A                                         |
| Maximum Junction Temperature (Plastic Package) ..... | $150^\circ\text{C}$                            |                                             |
| Maximum Storage Temperature Range .....              | $-65^\circ\text{C}$ to $150^\circ\text{C}$     |                                             |
| Maximum Lead Temperature (Soldering 10s) .....       | $300^\circ\text{C}$<br>(SOIC - Lead Tips Only) |                                             |

**CAUTION:** Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

#### NOTE:

- $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.

### Electrical Specifications $V_{\text{SUPPLY}} = \pm 5\text{V}$ , $A_V = +1$ , $R_F = 510\Omega$ , $R_L = 100\Omega$ , Unless Otherwise Specified

| PARAMETER                                                               | TEST CONDITIONS                 | (NOTE 2)<br>TEST LEVEL | TEMP.<br>( $^\circ\text{C}$ ) | MIN       | TYP       | MAX | UNITS                        |
|-------------------------------------------------------------------------|---------------------------------|------------------------|-------------------------------|-----------|-----------|-----|------------------------------|
| <b>INPUT CHARACTERISTICS</b>                                            |                                 |                        |                               |           |           |     |                              |
| Input Offset Voltage (Note 3)                                           |                                 | A                      | 25                            | -         | 2         | 6   | mV                           |
|                                                                         |                                 | A                      | Full                          | -         | -         | 10  | mV                           |
| Input Offset Voltage Drift                                              |                                 | C                      | Full                          | -         | 10        | -   | $\mu\text{V}/^\circ\text{C}$ |
| $V_{IO}$ CMRR                                                           | $\Delta V_{CM} = \pm 2\text{V}$ | A                      | 25                            | 40        | 46        | -   | dB                           |
|                                                                         |                                 | A                      | Full                          | 38        | -         | -   | dB                           |
| $V_{IO}$ PSRR                                                           | $\Delta V_S = \pm 1.25\text{V}$ | A                      | 25                            | 45        | 50        | -   | dB                           |
|                                                                         |                                 | A                      | Full                          | 42        | -         | -   | dB                           |
| Non-Inverting Input Bias Current (Note 3)                               | $+I_N = 0\text{V}$              | A                      | 25                            | -         | 25        | 40  | $\mu\text{A}$                |
|                                                                         |                                 | A                      | Full                          | -         | -         | 65  | $\mu\text{A}$                |
| $+I_{BIAS}$ Drift                                                       |                                 | C                      | Full                          | -         | 40        | -   | $\text{nA}/^\circ\text{C}$   |
| $+I_{BIAS}$ CMS                                                         | $\Delta V_{CM} = \pm 2\text{V}$ | A                      | 25                            | -         | 20        | 40  | $\mu\text{A}/\text{V}$       |
|                                                                         |                                 | A                      | Full                          | -         | -         | 50  | $\mu\text{A}/\text{V}$       |
| Inverting Input Bias Current (Note 3)                                   | $-I_N = 0\text{V}$              | A                      | 25                            | -         | 12        | 50  | $\mu\text{A}$                |
|                                                                         |                                 | A                      | Full                          | -         | -         | 60  | $\mu\text{A}$                |
| $-I_{BIAS}$ Drift                                                       |                                 | C                      | Full                          | -         | 40        | -   | $\text{nA}/^\circ\text{C}$   |
| $-I_{BIAS}$ CMS                                                         | $\Delta V_{CM} = \pm 2\text{V}$ | A                      | 25                            | -         | 1         | 7   | $\mu\text{A}/\text{V}$       |
|                                                                         |                                 | A                      | Full                          | -         | -         | 10  | $\mu\text{A}/\text{V}$       |
| $-I_{BIAS}$ PSS                                                         | $\Delta V_S = \pm 1.25\text{V}$ | A                      | 25                            | -         | 6         | 15  | $\mu\text{A}/\text{V}$       |
|                                                                         |                                 | A                      | Full                          | -         | -         | 27  | $\mu\text{A}/\text{V}$       |
| Non-Inverting Input Resistance                                          |                                 | A                      | 25                            | 25        | 50        | -   | $\text{k}\Omega$             |
| Inverting Input Resistance                                              |                                 | C                      | 25                            | -         | 20        | 30  | $\Omega$                     |
| Input Capacitance (Either Input)                                        |                                 | B                      | 25                            | -         | 2         | -   | pF                           |
| Input Common Mode Range                                                 |                                 | C                      | Full                          | $\pm 2.5$ | $\pm 3.0$ | -   | V                            |
| Input Noise Voltage (Note 3)                                            | 100kHz                          | B                      | 25                            | -         | 4         | -   | $\text{nV}/\sqrt{\text{Hz}}$ |
| +Input Noise Current (Note 3)                                           | 100kHz                          | B                      | 25                            | -         | 18        | -   | $\text{pA}/\sqrt{\text{Hz}}$ |
| -Input Noise Current (Note 3)                                           | 100kHz                          | B                      | 25                            | -         | 21        | -   | $\text{pA}/\sqrt{\text{Hz}}$ |
| <b>TRANSFER CHARACTERISTICS</b> $A_V = +2$ , Unless Otherwise Specified |                                 |                        |                               |           |           |     |                              |
| Open Loop Transimpedance (Note 3)                                       |                                 | B                      | 25                            | -         | 300       | -   | $\text{k}\Omega$             |

## HFA1100

### Electrical Specifications $V_{\text{SUPPLY}} = \pm 5\text{V}$ , $A_V = +1$ , $R_F = 510\Omega$ , $R_L = 100\Omega$ , Unless Otherwise Specified (Continued)

| PARAMETER                                                             | TEST CONDITIONS                                                          | (NOTE 2)<br>TEST LEVEL | TEMP.<br>(°C) | MIN       | TYP        | MAX       | UNITS            |
|-----------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------|---------------|-----------|------------|-----------|------------------|
| -3dB Bandwidth (Note 3)                                               | $V_{\text{OUT}} = 0.2V_{\text{P-P}}$ ,<br>$A_V = +1$                     | B                      | 25            | 530       | 850        | -         | MHz              |
| -3dB Bandwidth                                                        | $V_{\text{OUT}} = 0.2V_{\text{P-P}}$ ,<br>$A_V = +2$ , $R_F = 360\Omega$ | B                      | 25            | -         | 670        | -         | MHz              |
| Full Power Bandwidth                                                  | $V_{\text{OUT}} = 4V_{\text{P-P}}$ ,<br>$A_V = -1$                       | B                      | 25            | -         | 300        | -         | MHz              |
| Gain Flatness (Note 3)                                                | To 100MHz                                                                | B                      | 25            | -         | $\pm 0.14$ | -         | dB               |
| Gain Flatness                                                         | To 50MHz                                                                 | B                      | 25            | -         | $\pm 0.04$ | -         | dB               |
| Gain Flatness                                                         | To 30MHz                                                                 | B                      | 25            | -         | $\pm 0.01$ | -         | dB               |
| Linear Phase Deviation (Note 3)                                       | DC to 100MHz                                                             | B                      | 25            | -         | 0.6        | -         | Degrees          |
| Differential Gain                                                     | NTSC, $R_L = 75\Omega$                                                   | B                      | 25            | -         | 0.03       | -         | %                |
| Differential Phase                                                    | NTSC, $R_L = 75\Omega$                                                   | B                      | 25            | -         | 0.05       | -         | Degrees          |
| Minimum Stable Gain                                                   |                                                                          | A                      | Full          | 1         | -          | -         | V/V              |
| <b>OUTPUT CHARACTERISTICS</b> $A_V = +2$ , Unless Otherwise Specified |                                                                          |                        |               |           |            |           |                  |
| Output Voltage (Note 3)                                               | $A_V = -1$                                                               | A                      | 25            | $\pm 3.0$ | $\pm 3.3$  | -         | V                |
|                                                                       |                                                                          | A                      | Full          | $\pm 2.5$ | $\pm 3.0$  | -         | V                |
| Output Current                                                        | $R_L = 50\Omega$ , $A_V = -1$                                            | A                      | 25, 85        | 50        | 60         | -         | mA               |
|                                                                       |                                                                          | A                      | -40           | 35        | 50         | -         | mA               |
| DC Closed Loop Output Impedance (Note 3)                              |                                                                          | B                      | 25            | -         | 0.07       | -         | $\Omega$         |
| 2nd Harmonic Distortion (Note 3)                                      | 30MHz, $V_{\text{OUT}} = 2V_{\text{P-P}}$                                | B                      | 25            | -         | -56        | -         | dBc              |
| 3rd Harmonic Distortion (Note 3)                                      | 30MHz, $V_{\text{OUT}} = 2V_{\text{P-P}}$                                | B                      | 25            | -         | -80        | -         | dBc              |
| 3rd Order Intercept (Note 3)                                          | 100MHz                                                                   | B                      | 25            | 20        | 30         | -         | dBm              |
| 1dB Compression                                                       | 100MHz                                                                   | B                      | 25            | 15        | 20         | -         | dBm              |
| <b>TRANSIENT RESPONSE</b> $A_V = +2$ , Unless Otherwise Specified     |                                                                          |                        |               |           |            |           |                  |
| Rise Time                                                             | $V_{\text{OUT}} = 2.0\text{V Step}$                                      | B                      | 25            | -         | 900        | -         | ps               |
| Overshoot (Note 3)                                                    | $V_{\text{OUT}} = 2.0\text{V Step}$                                      | B                      | 25            | -         | 10         | -         | %                |
| Slew Rate                                                             | $A_V = +1$ , $V_{\text{OUT}} = 5V_{\text{P-P}}$                          | B                      | 25            | -         | 1400       | -         | V/ $\mu\text{s}$ |
| Slew Rate                                                             | $A_V = +2$ , $V_{\text{OUT}} = 5V_{\text{P-P}}$                          | B                      | 25            | 1850      | 2300       | -         | V/ $\mu\text{s}$ |
| 0.1% Settling (Note 3)                                                | $V_{\text{OUT}} = 2\text{V to } 0\text{V}$                               | B                      | 25            | -         | 11         | -         | ns               |
| 0.2% Settling (Note 3)                                                | $V_{\text{OUT}} = 2\text{V to } 0\text{V}$                               | B                      | 25            | -         | 7          | -         | ns               |
| Overdrive Recovery Time                                               | 2X Overdrive                                                             | B                      | 25            | -         | 7.5        | 10        | ns               |
| <b>POWER SUPPLY CHARACTERISTICS</b>                                   |                                                                          |                        |               |           |            |           |                  |
| Supply Voltage Range                                                  |                                                                          | B                      | Full          | $\pm 4.5$ | -          | $\pm 5.5$ | V                |
| Supply Current (Note 3)                                               |                                                                          | A                      | 25            | -         | 21         | 26        | mA               |
|                                                                       |                                                                          | A                      | Full          | -         | -          | 33        | mA               |

#### NOTES:

- Test Level: A. Production Tested; B. Typical or Guaranteed Limit Based on Characterization; C. Design Typical for Information Only.
- See Typical Performance Curves for more information.

## HFA1100

### Application Information

#### Optimum Feedback Resistor ( $R_F$ )

The enclosed plots of inverting and non-inverting frequency response detail the performance of the HFA1100 in various gains. Although the bandwidth dependency on  $A_{CL}$  isn't as severe as that of a voltage feedback amplifier, there is an appreciable decrease in bandwidth at higher gains. This decrease can be minimized by taking advantage of the current feedback amplifier's unique relationship between bandwidth and  $R_F$ . All current feedback amplifiers require a feedback resistor, even for unity gain applications, and the  $R_F$ , in conjunction with the internal compensation capacitor, sets the dominant pole of the frequency response. Thus, the amplifier's bandwidth is inversely proportional to  $R_F$ . The HFA1100 design is optimized for a 510 $\Omega$   $R_F$ , at a gain of +1. Decreasing  $R_F$  in a unity gain application decreases stability, resulting in excessive peaking and overshoot (Note: Capacitive feedback causes the same problems due to the feedback impedance decrease at higher frequencies). At higher gains the amplifier is more stable, so  $R_F$  can be decreased in a trade-off of stability for bandwidth. The table below lists recommended  $R_F$  values for various gains, and the expected bandwidth.

| $A_{CL}$ | $R_F$ ( $\Omega$ ) | BW (MHz) |
|----------|--------------------|----------|
| +1       | 510                | 850      |
| -1       | 430                | 580      |
| +2       | 360                | 670      |
| +5       | 150                | 520      |
| +10      | 180                | 240      |
| +19      | 270                | 125      |

#### 5V Single Supply Operation

This amplifier operates at single supply voltages down to 4.5V. The table below details the amplifier's performance with a single 5V supply. The dramatic supply current reduction at this operating condition (refer also to Figure 23) makes these op amps even better choices for low power 5V systems. Refer to Application Note AN9745 for further information.

| PARAMETER                             | TYP           |
|---------------------------------------|---------------|
| Input Common Mode Range               | 1V to 4V      |
| -3dB BW ( $A_V = +2$ )                | 267MHz        |
| Gain Flatness (to 50MHz, $A_V = +2$ ) | 0.05dB        |
| Output Voltage ( $A_V = -1$ )         | 1.3V to 3.8V  |
| Slew Rate ( $A_V = +2$ )              | 475V/ $\mu$ s |
| 0.1% Settling Time                    | 17ns          |
| Supply Current                        | 5.5mA         |

#### Use of Die in Hybrid Applications

This amplifier is designed with compensation to negate the package parasitics that typically lead to instabilities. As a result, the use of die in hybrid applications results in overcompensated performance due to lower parasitic capacitances. Reducing  $R_F$  below the recommended values for packaged units will solve the problem. For  $A_V = +2$  the recommended starting point is 300 $\Omega$ , while unity gain applications should try 400 $\Omega$ .

#### PC Board Layout

The frequency performance of this amplifier depends a great deal on the amount of care taken in designing the PC board.

**The use of low inductance components such as chip resistors and chip capacitors is strongly recommended, while a solid ground plane is a must!**

Attention should be given to decoupling the power supplies. A large value (10 $\mu$ F) tantalum in parallel with a small value chip (0.1 $\mu$ F) capacitor works well in most cases.

Terminated microstrip signal lines are recommended at the input and output of the device. Output capacitance, such as that resulting from an improperly terminated transmission line will degrade the frequency response of the amplifier and may cause oscillations. In most cases, the oscillation can be avoided by placing a resistor in series with the output.

Care must also be taken to minimize the capacitance to ground seen by the amplifier's inverting input. The larger this capacitance, the worse the gain peaking, resulting in pulse overshoot and possible instability. To this end, it is recommended that the ground plane be removed under traces connected to pin 2, and connections to pin 2 should be kept as short as possible.

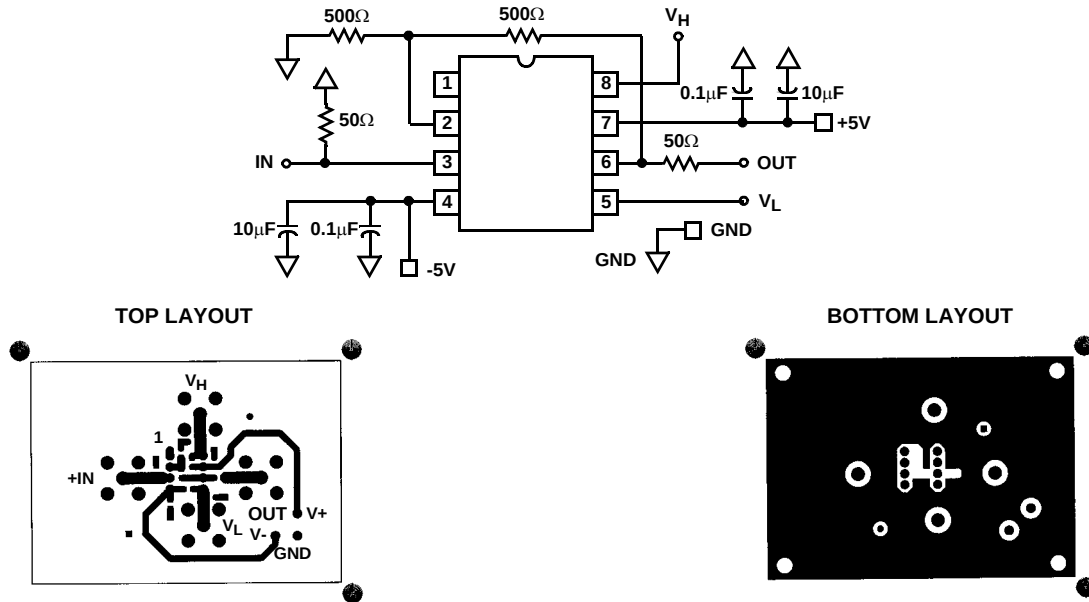
An example of a good high frequency layout is the Evaluation Board shown below.

#### Evaluation Board

An evaluation board is available for the HFA1100 (Part Number HFA11XXEVAL). Please contact your local sales office for information.

## HFA1100

The layout and schematic of the board are shown below:



### Typical Performance Curves $V_{\text{SUPPLY}} = \pm 5\text{V}$ , $R_F = 510\Omega$ , $T_A = 25^\circ\text{C}$ , $R_L = 100\Omega$ , Unless Otherwise Specified

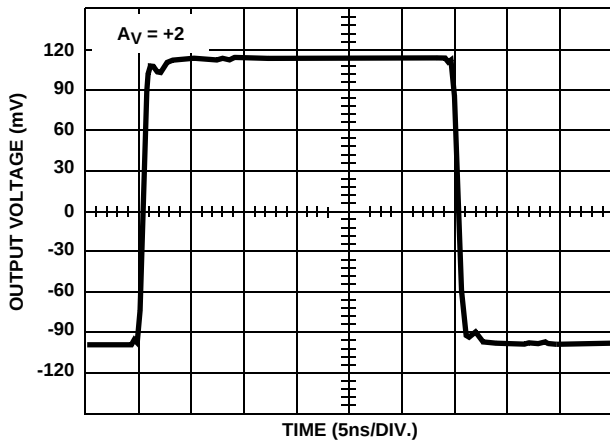


FIGURE 1. SMALL SIGNAL PULSE

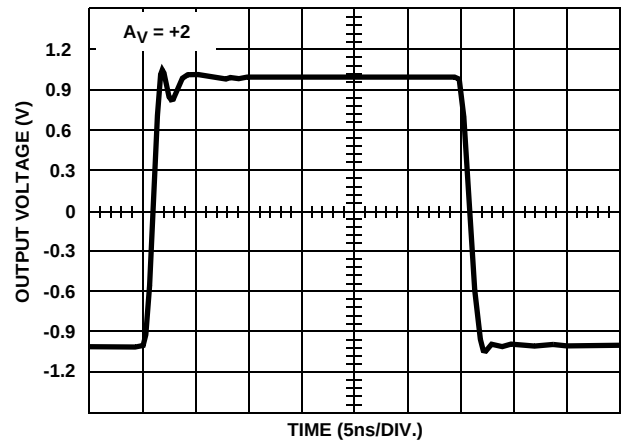


FIGURE 2. LARGE SIGNAL PULSE

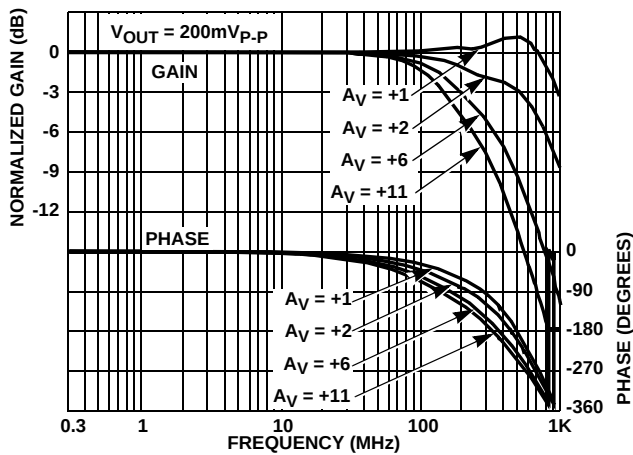


FIGURE 3. NON-INVERTING FREQUENCY RESPONSE

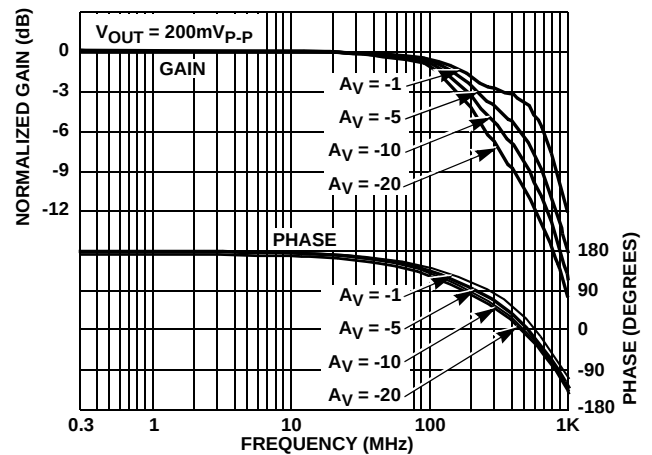
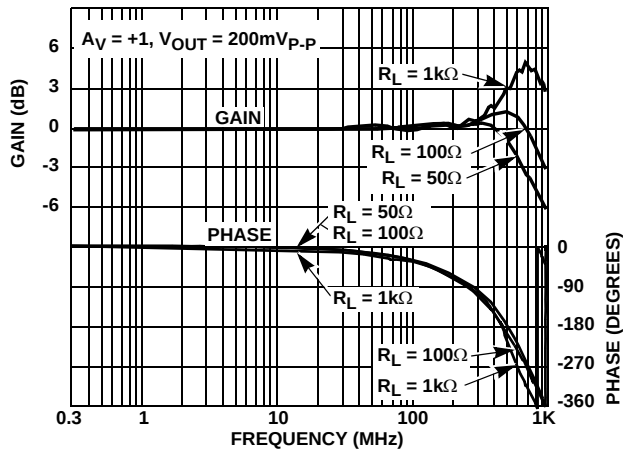
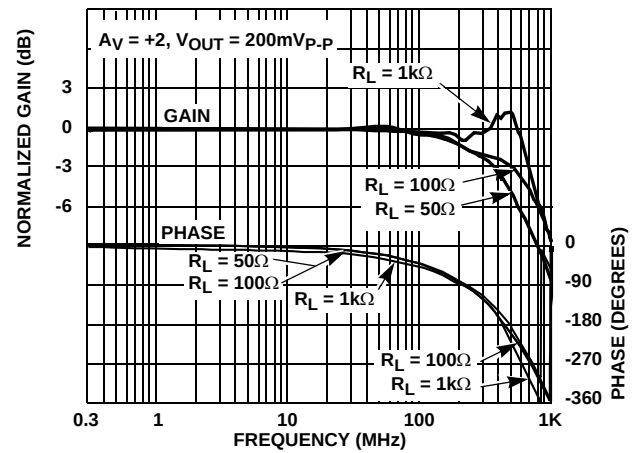
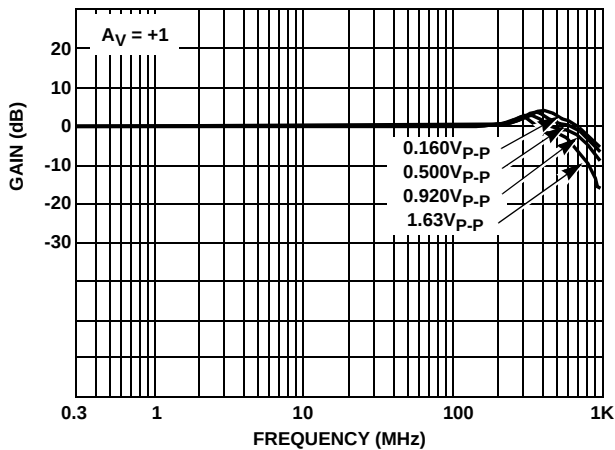
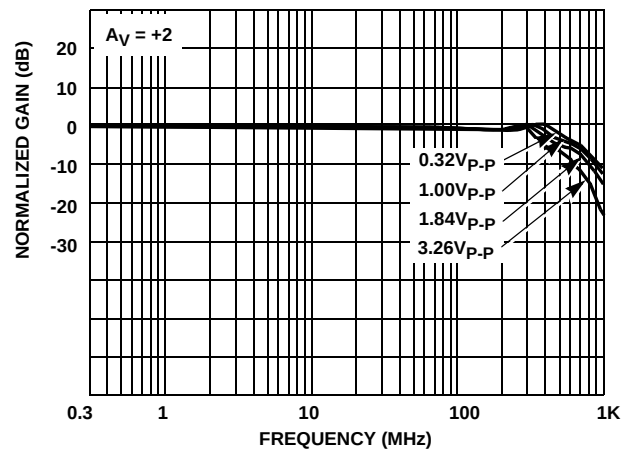
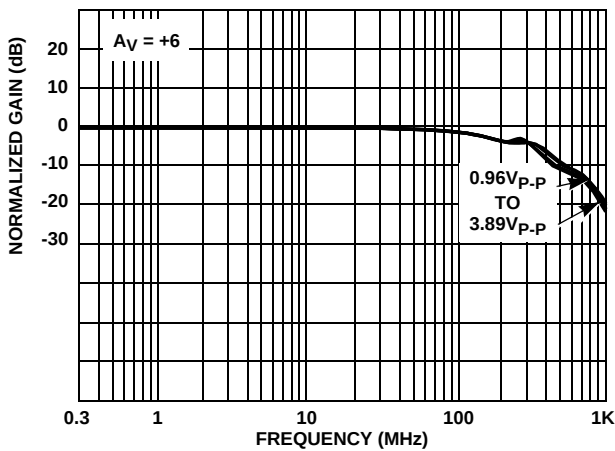
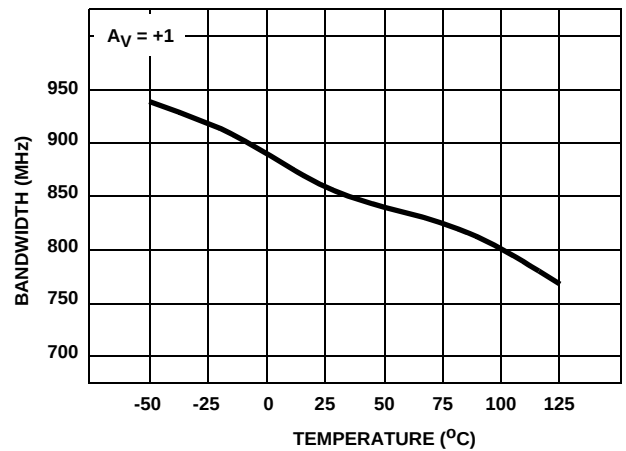


FIGURE 4. INVERTING FREQUENCY RESPONSE

**Typical Performance Curves**  $V_{\text{SUPPLY}} = \pm 5\text{V}$ ,  $R_F = 510\Omega$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 100\Omega$ , Unless Otherwise Specified (Continued)

**FIGURE 5. FREQUENCY RESPONSE FOR VARIOUS LOAD RESISTORS**

**FIGURE 6. FREQUENCY RESPONSE FOR VARIOUS LOAD RESISTORS**

**FIGURE 7. FREQUENCY RESPONSE FOR VARIOUS OUTPUT VOLTAGES**

**FIGURE 8. FREQUENCY RESPONSE FOR VARIOUS OUTPUT VOLTAGES**

**FIGURE 9. FREQUENCY RESPONSE FOR VARIOUS OUTPUT VOLTAGES**

**FIGURE 10. -3dB BANDWIDTH vs TEMPERATURE**

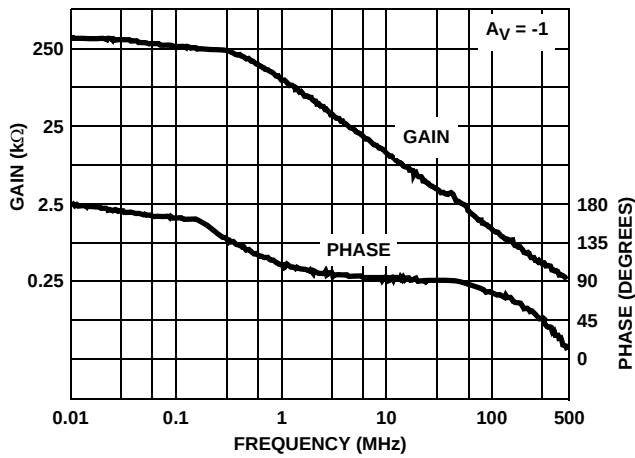
**Typical Performance Curves**  $V_{\text{SUPPLY}} = \pm 5\text{V}$ ,  $R_F = 510\Omega$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 100\Omega$ , Unless Otherwise Specified (Continued)


FIGURE 11. OPEN LOOP TRANSIMPEDANCE

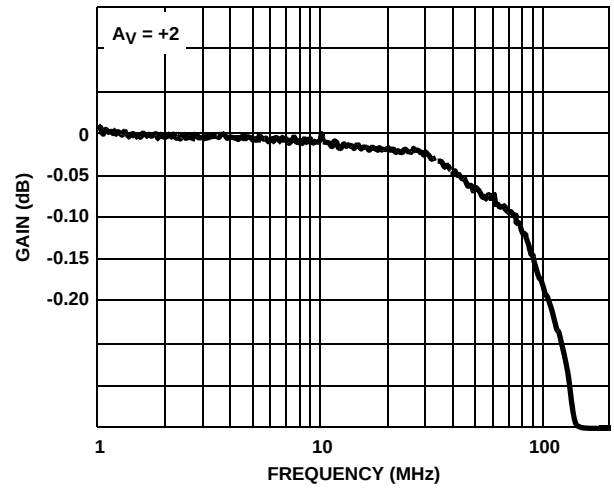


FIGURE 12. GAIN FLATNESS

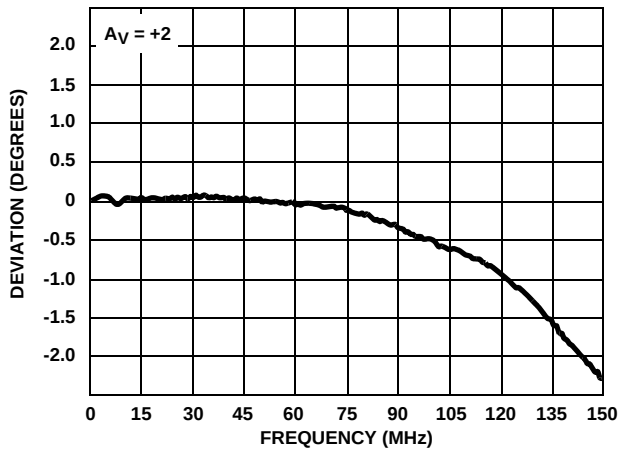


FIGURE 13. DEVIATION FROM LINEAR PHASE

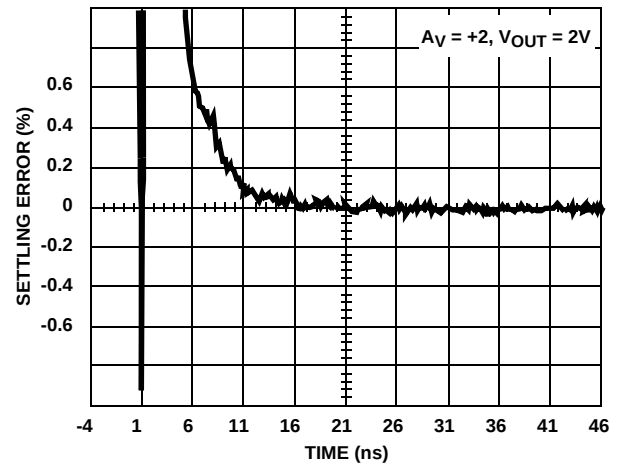


FIGURE 14. SETTLING RESPONSE

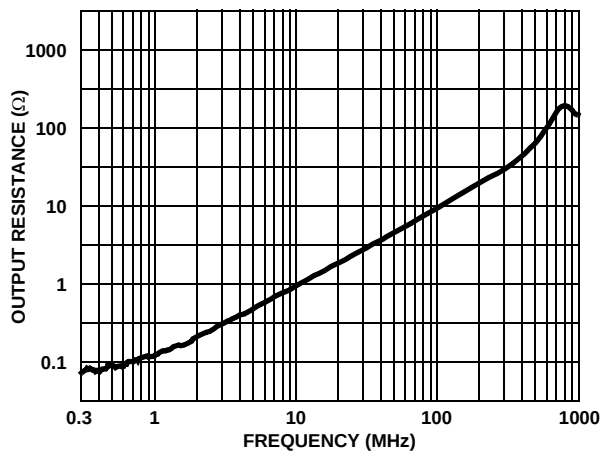


FIGURE 15. CLOSED LOOP OUTPUT RESISTANCE

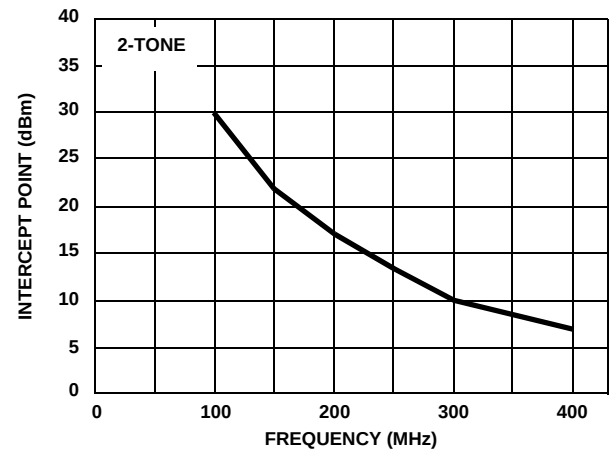


FIGURE 16. 3rd ORDER INTERMODULATION INTERCEPT

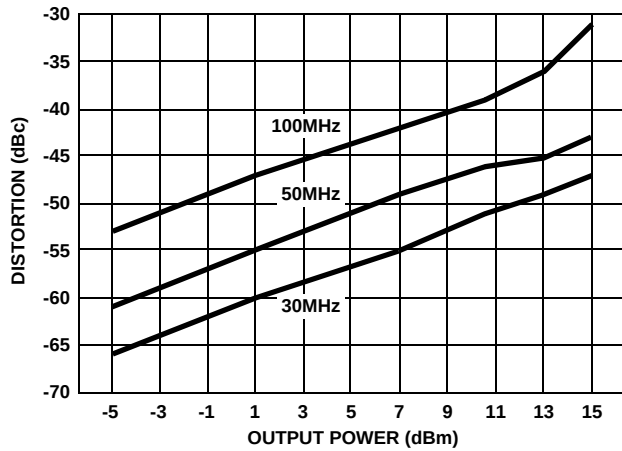
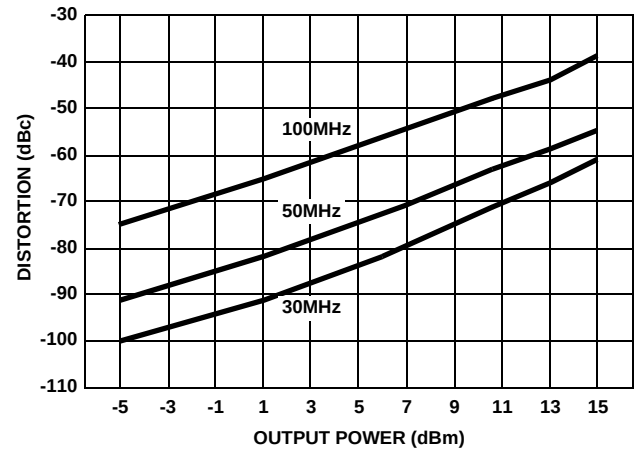
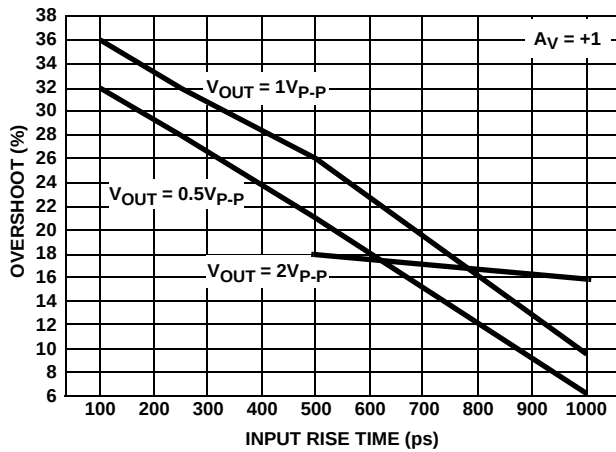
**Typical Performance Curves**  $V_{\text{SUPPLY}} = \pm 5\text{V}$ ,  $R_F = 510\Omega$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 100\Omega$ , Unless Otherwise Specified (Continued)
FIGURE 17. 2nd HARMONIC DISTORTION vs  $P_{\text{OUT}}$ FIGURE 18. 3rd HARMONIC DISTORTION vs  $P_{\text{OUT}}$ 

FIGURE 19. OVERSHOOT vs INPUT RISE TIME

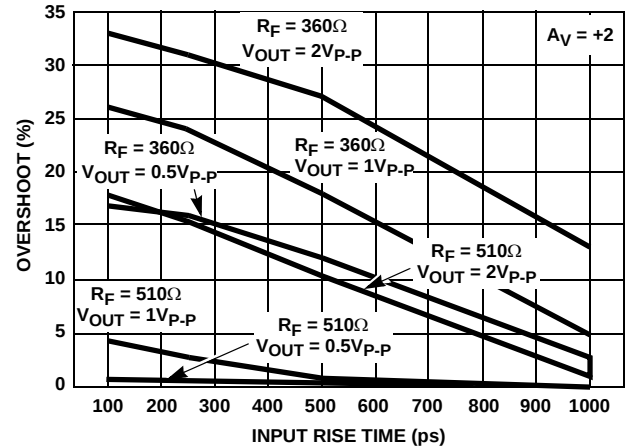


FIGURE 20. OVERSHOOT vs INPUT RISE TIME

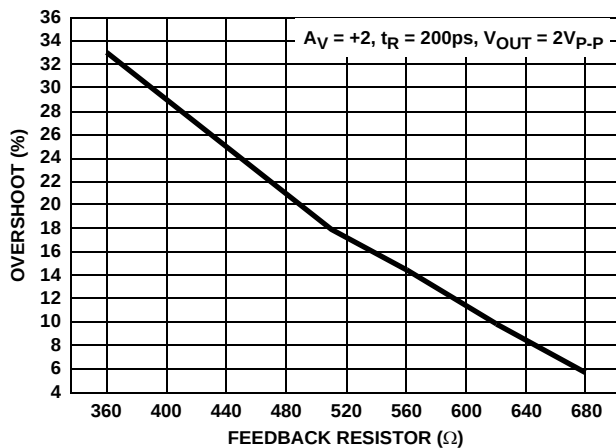


FIGURE 21. OVERSHOOT vs FEEDBACK RESISTOR

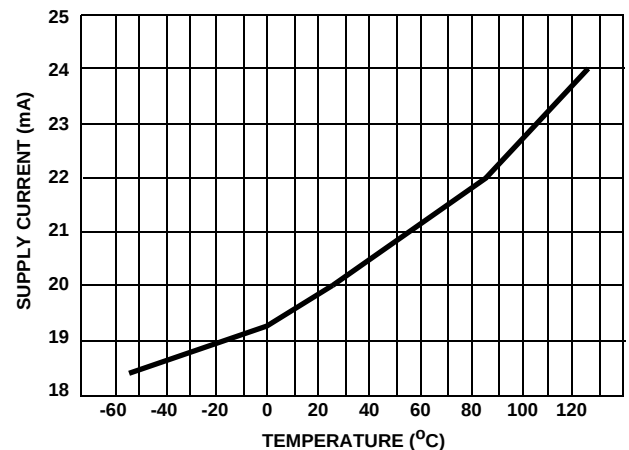


FIGURE 22. SUPPLY CURRENT vs TEMPERATURE

**Typical Performance Curves**  $V_{\text{SUPPLY}} = \pm 5\text{V}$ ,  $R_F = 510\Omega$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 100\Omega$ , Unless Otherwise Specified (Continued)

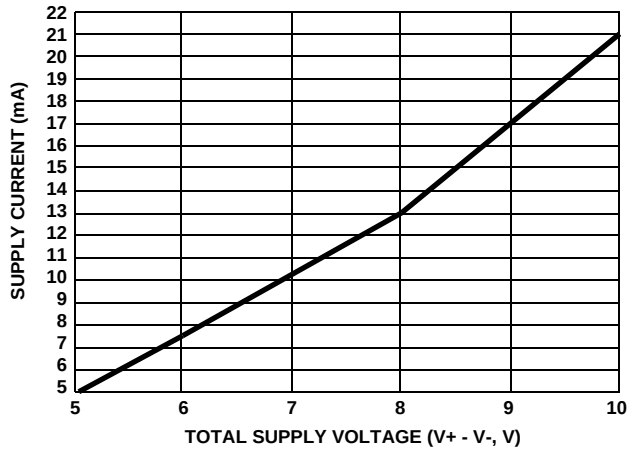


FIGURE 23. SUPPLY CURRENT vs SUPPLY VOLTAGE

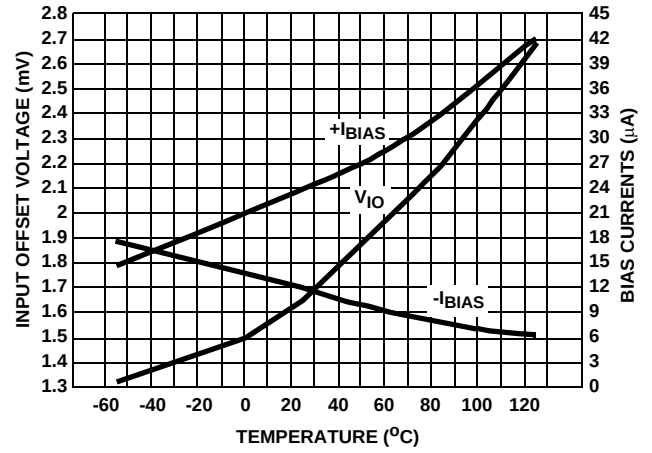


FIGURE 24.  $V_{IO}$  AND BIAS CURRENTS vs TEMPERATURE

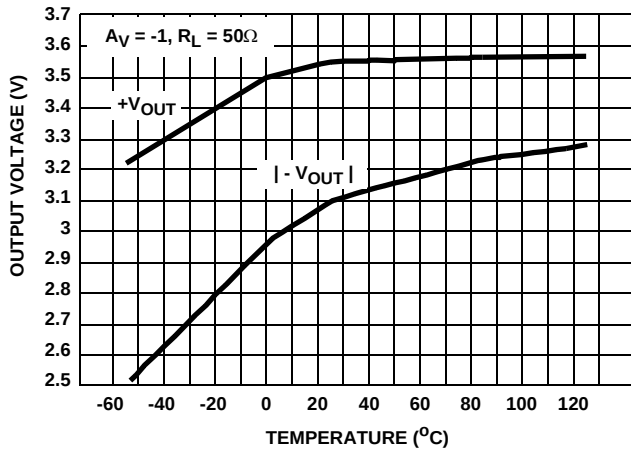


FIGURE 25. OUTPUT VOLTAGE vs TEMPERATURE

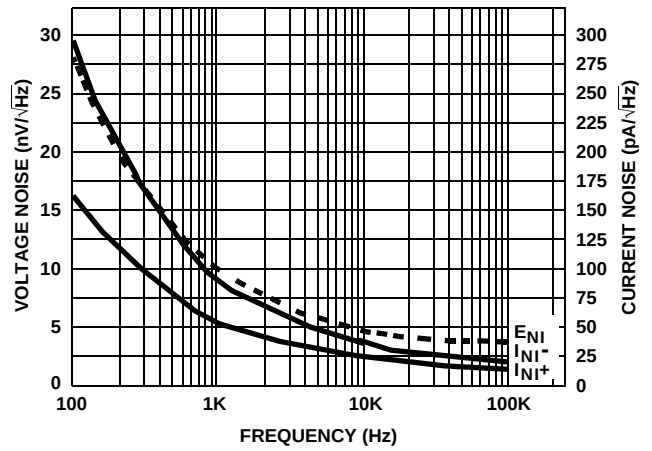


FIGURE 26. INPUT NOISE vs FREQUENCY

## HFA1100

### Die Characteristics

#### DIE DIMENSIONS:

63 mils x 44 mils x 19 mils  
1600 $\mu$ m x 1130 $\mu$ m

#### METALLIZATION:

Type: Metal 1: AlCu (2%)/TiW  
Thickness: Metal 1: 8k $\text{\AA}$   $\pm$  0.4k $\text{\AA}$   
Type: Metal 2: AlCu (2%)  
Thickness: Metal 2: 16k $\text{\AA}$   $\pm$  0.8k $\text{\AA}$

#### PASSIVATION:

Type: Nitride  
Thickness: 4k $\text{\AA}$   $\pm$  0.5k $\text{\AA}$

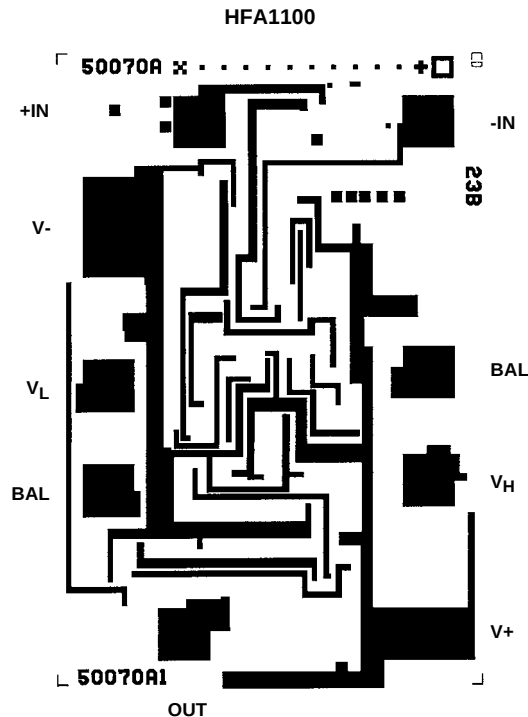
#### TRANSISTOR COUNT:

52

#### SUBSTRATE POTENTIAL (POWERED UP):

Floating (Recommend Connection to V-)

### Metallization Mask Layout



All Intersil U.S. products are manufactured, assembled and tested utilizing ISO9000 quality systems.  
Intersil Corporation's quality certifications can be viewed at [www.intersil.com/design/quality](http://www.intersil.com/design/quality)

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